CHAPTER I

INTRODUCTION AND BACKGROUND INFORMATION

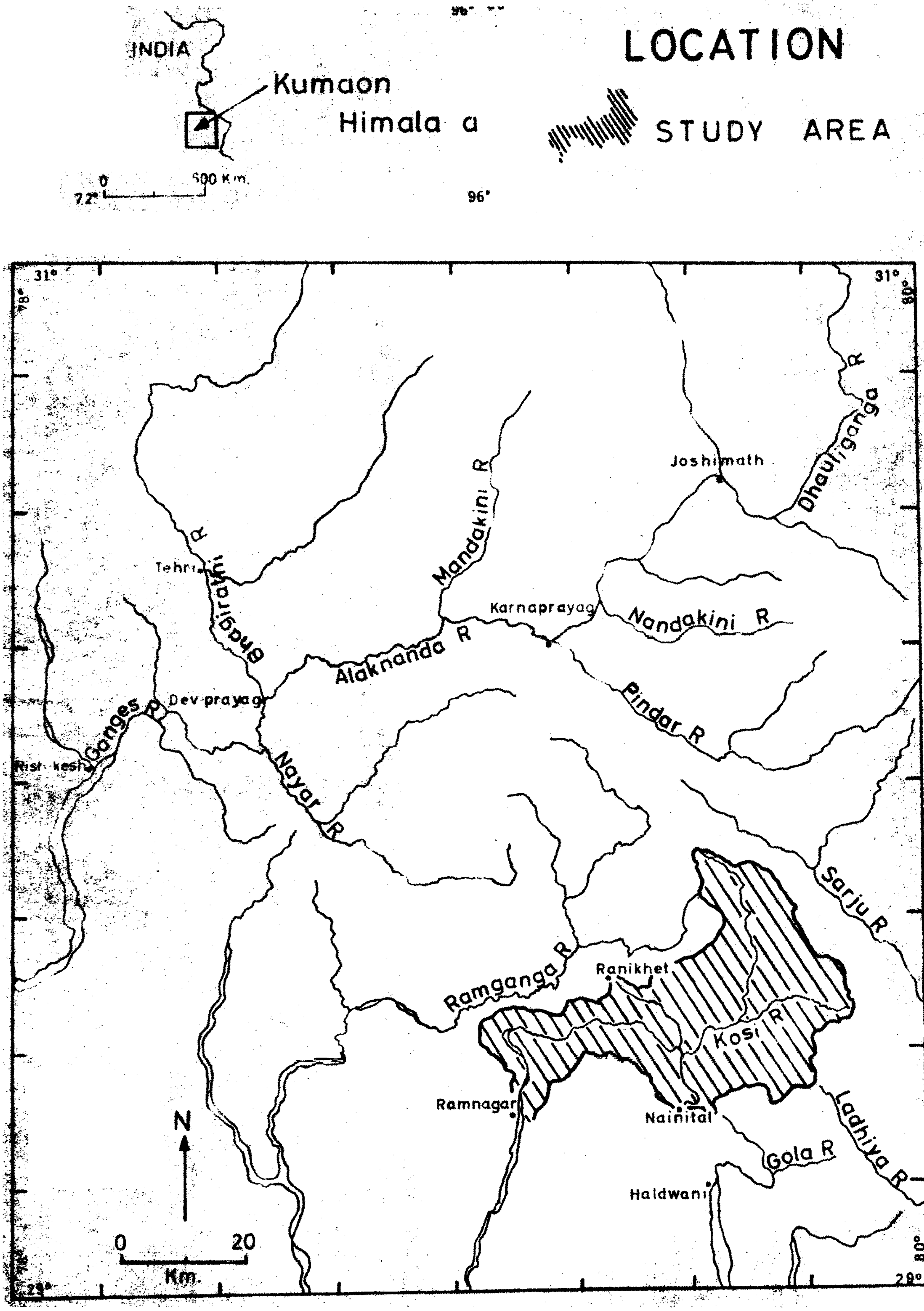
GENERAL

The fascinating high relief Himalayan terrain has always been a subject of new experience and challenge to the earth scientists, particularly the geologists and geomorphologists. Considerable work over a century has been done on the geological problems in the Himalayas, as a result of which a fairly detailed geological picture of the mountain chain has now emerged. However, the geographical knowledge is still scanty as little work on the geomorphic problems has been carried out in the past. It is only very recently that such type of work has been undertaken by a few geomorphologists and geologists in various Himalayan region, and from whatever limited studies that have been undertaken by them, it has become quite clear that the evolution of the Himalayan landscape has essentially been controlled by the geology and tectonics of this great mountain chain. Thus, it is most essential that in all the geomorphic investigations in Himalaya, adequate consideration of the geological framework has to be made. The present study comprises one such attempt and pertains to the drainage basin of the river Kosi (a tributary of the river Ramganga of the Ganges system) that drains the central Kumaon Himalaya (Fig. 1).

The present geomorphic investigation in the KOSI drainage basin by the author is a modest step towards initiating systematic landscape studies in this part of the great Himalaya.

In the course of last several years a team of workers under the guidance of Prof. S.S. Merh of the M.S. University of Baroda has been carrying out detailed geological and structural studies of the rocks of this basin, and the present study, also under the supervision of Prof. Merh, is aimed at providing the geomorphic counterpart of the total picture of the morphology of the Kosi basin. The

Fig 1.


LOCATION
STUDY AREA
INDIA
Kumaon
Himala a
0
500 Km.
72°
96°
31°
78°
80°
29°
Joshimath
Dhauliganga R
Mandakini R
Bhagirathi R
Tehri
Karnaprayag
Nandakini R
Alaknanda R
Devprayag
Ganges R
Rishikesh
Pindar R
Nayar R
Sarju R
Ramganga R
Ranikhet
Kosi R
Ramnagar
Nainital
Ladhiya R
Gola R
Haldwani
N
0
20
Km.

author has confined himself mostly to the drainage analysis and has carried out detailed studies of the latest topographical maps and the aerial photographs of the basin. The investigation was adequately supported by a number of field checks in selected areas. The results of his study included in this thesis, reveal interesting morphological characteristics bringing out the role of lithostratigraphic and structural controls in the sculpturing of the Kosi basin.

HIMALAYA IN GENERAL

Gansser (1964) has recognised following four geographic sections of the Himalaya:

	Extent	Length
Panjab Himalaya	Between the rivers Indus and Sutlej	550 km
Kumaon Himalaya	Between the rivers Sutlej and Kali	320 km
Nepal Himalaya	Between the rivers Kali and Tista	800 km
Assam Himalaya	Between the rivers Tista and Brahmputra	720 km

Longitudinally, the Himalaya is divided into four parts from south to north:

Outer Himalayan Zone : (Siwalik foot-hills)

These are the first foothill ranges that rise from the southern alluvial plains, and show considerable variation in width, ranging from 8 to 48 km, and rising to a maximum altitude of 1300 metres. These are composed of upper Tertiary fresh water deposits. At places, the foot-hills are separated from the Lesser Himalaya by flat bottom valleys called 'Duns' which are covered by Recent gravels and alluvium.

Lesser Himalayan Zone :

A zone of parallel ranges and scattered mountains higher than the Siwalik foot-hills. The width of this zone varies from 60 to 80 km, and the heights range between 2000 to 3300 metres. The geology of this zone is complex and the rock types are both crystalline and unfossiliferous metasediments belonging to Pre-Cambrian, Palaeozoic and early Mesozoic ages.

Great Himalayan Zone :	The innermost line of the Himalayan ranges with show-clad peaks. This zone rises abruptly in elevation from the Lesser Himalaya, the average height being about 6800 metres. The rocks of this zone comprise crystallines, mainly granites and gneisses, containing in part, metasedimentary horizons. Lithostratigraphically, these rocks perhaps represent the 'root zone' of the 'Nappes' encountered in the Lesser Himalaya.
Trans-Himalayan Zone :	A zone of about 40 km width, and to the north of the Great Himalayan Zone. The average altitude is about 3000 to 4300 metres. The rocks belong to the Tibetan facies and comprise a sequence upto Eocene. These marine sedimentary rocks have a good and well preserved fossil assemblage.

KUMAON HIMALAYA

Regional Geologic Set Up

The region of Kumaon Himalaya between the rivers Ganges and Sarju represents a typical cross-section of the Himalaya, affected by glacial, fluvioglacial and fluvial processes operating over varying lithostratigraphic units of diverse structural set up (Fig. 2). For the purpose of the present study, the regional geological picture as worked out by Gansser (1964) has been taken as the basis and superimposed on the drainage net. Accordingly, the author has recognised following seven litho-tectonic units in the region:-

Alluvial Plain: The alluvial plain comprises two definite zones. The zone closer to the foot-hills is composed of gravel and boulders mixed with sand, and is formed due to the coalescence of alluvial fans in the form of a piedmont plain. The zone to the south of it, is composed of fine to coarse sands with appreciable silt content. These zones stand out very clearly even on the topographic maps, revealing distinctive drainage patterns.

Siwalik Rocks: From the plains further north, the first encountered foot-hills are those of the Siwalik system, composed of sandstones, shales, clay and boulder beds mostly dipping due NE. In general, the dips vary between 25° to 40°. The Siwaliks have been divided into Upper, Middle and Lower, depending on their lithostratigraphy and fossil content. The contact between the Siwaliks and the Pre-Siwaliks is a tectonic one, and has been referred to as the Main Boundary Fault. This dislocation dips due NE and along this the Pre-Siwalik rocks have been thrust over.

Naini Tal Synform of Krol-Nagthat Group : The hill ranges of Lesser Himalaya in the immediate vicinity of the foot-hills are composed of the rocks of the Krol-Nagthat group. This group has been assigned a late Pre-Cambrian to Middle Palaeozoic age, and comprises varied rock types, i.e., limestones, shales and quartzites. Structurally, this zone has a synformal disposition in the Naini Tal area. This syncline is cut by the Main Boundary Fault in the southwest, and is flanked by a narrow anticlinal structure to the north-east. The Naini Tal synform has mainly folded the rocks of the Krol Series.

Landsdowne Synform: This structure also forms a part of the Lesser Himalaya, lying to the north-west of Naini Tal synform. Here the crystalline rocks of older age rest over a synformally folded thrust, below which occur a complete sequence of Krol and younger sediments. This synform is bound by the Main Boundary fault to the south, beyond which the foot-hills begin.

Dudhatoli-Almora Synform: This synform too, like the Landsdowne structure, represents a folded thrust sheet, such that older crystallines rest over the younger Nagthats. But unlike the latter, this folded structure is much larger and is 2 to 3 times wider. It covers a major portion of the Lesser Himalaya. The synformal axis trends in ENE-WSW direction with flexures at intervals. The southern limb of this synform is wider being low in dip, whereas the northern limb is of narrow width due to steeper dips and a faulted northern contact. The rock types in this zone are mainly puckered phyllonites, quartzites with slates, schists, gneisses and gneissic granites, the last two rocks occupying the highest elevations.

Nagthat-Deoban Group: The zone between the Dudatoli-Almora syncline and the Central Himalayan Zone consists mainly of the rocks of Nagthat-Deoban group. These comprise of a pair of steep asymmetrical anticlinal structures, in between which the older crystallines rest in a synform (Baijnath synform) separated by a folded thrust. The rocks of this group, that underlie the crystalline schists and gneisses are composed mainly of metasediments i.e. quartzites, compact limestones and slates. This zone of anticlines and synclines marks the northern and higher part of the Lesser Himalaya.

Central Crystallines: These lying to the north of the Main Central Thrust, rise abruptly, and forming the high hill ranges of the Central Himalaya, are composed mainly of granites and gneisses.

Morphologic Set Up

The youthful Himalayan landscape is being continuously washed and eroded by torrential rivers which flow from the north and are all snowfed. In the section between Ganges and Sarju rivers, the most important Himalayan river is the Alaknanda, which erodes and drains the severe slopes of the Central Himalayan range. Its general flow direction is towards SW with numerous NS bends. Several tributaries join it from north and south. Among the rivers joining from north are the Bhagirathi (with its confluence at Devaprayag) and the Mandakini which meets near Rudraprayag. The rivers joining from the east and south are Birehiganga, Nandakini, Pindar and Nayar. All these rivers except Nayar, originate from glaciers, and their courses show a typical north-westerly bend. The tributaries of Alaknanda that join it in the plains, after independently draining the Lesser Himalaya, are the Ramganga, Kosi and Gola. These rivers are fed solely by rain water. These rivers show acute arcuate bends while cutting through the Siwalik foot-hills, and broad arcuate bends in the higher Pre-Siwaliks. Through Siwalik foot-hills, the arc points towards NW while the broad river arcs through Lesser Himalaya point towards SE. The drainage divide that separates the north-draining tributaries of Ramganga from those draining due south is aligned in a ENE-WSW direction, which also corresponds to the general alignment of the synformal axis of the Dudhatoli crystalline mass.

The Alaknanda and its tributaries originating from glaciers, cut through deep gorges and at intervals have deposited a number of terraces at various levels in the wider stretches of the river valleys. This is an oft repeated feature observed all along these Himalayan rivers. Author (1972) has earlier studied these aspects along the Alaknanda and Birehiganga rivers and according to him, this terrace formation is mostly due to 'bottle-necking'.

The landscape in the Central Himalayan zone is very rugged with steep precipitous slopes and deep gorges, whereas in the Lesser Himalaya, on the Nagthat-Deoban group, nearer the Main Central Thrust, it remains steep but becomes less rugged. On the other hand, in the region of thrusted crystallines occurring as nappes, the landscape is more subdued and the valleys are broad, with isolated peaks standing out prominently, so much so that the Himalayan snow-clad peaks are visible from long distances. The metasedimentary zone of the Krol-Nagthat group however shows greater heights in the south near the Siwalik foot-hills. Beyond this, there is sudden topographic break. The Siwalik hills are elongate ridges sharply crested, asymmetric and reveal a regular pattern of lithostratigraphic control. Even with a little field acquaintance, it is not difficult to recognise the Siwalik hills from the Pre-Siwaliks. The rivers in this zone are wide with a number of alluvial terraces on either sides. The beds are bouldery and channels anastomasing in wider stretches. The channel banks and the hill crests are associated with short steep slopes, though the generalised slopes follow the dips of the strata and range between 20° to 25°. The streams are seasonal, but during monsoon period, due to heavy rainfall they become torrential.

STUDY AREA

Location

The study area includes the entire catchment of the

Kosi drainage (Fig. 1). The area is bound by its drainage divide forming a reverse 'S', aligned in E-W direction. To its north and west is the catchment of the Ramganga river, to the east is the catchment of the rivers Sarju and Ladhiya. Beyond its southern limit flows the Gola river. Important location along the northern divide of the Kosi basin is Ranikhet, and on the southern divide is Naini Tal. The town of Almora occupies the heart of the basin. The river debouches into the plains near Ramnagar.

The study area is covered in parts of the Survey of India Topo Sheet Nos. 53 0/2,3,6,7,9,10,11,14 and 15, and lies between the E. Longitudes 79°12' to 79°52' and N. Latitudes 29°22' to 29°52'. It covers nearly 1756 sq km area, and comes under the Naini Tal and Almora districts of Uttar Pradesh.

Access

Almost all parts of the Kosi drainage basin are easily accessible. Right from Ramnagar (which is both the mouth of the basin as well as the rail head of a metre gauge line) there is a fair weather road which climbs up the divide through the basin and reaches Ranikhet via Bhatronjkhal - a distance of near 96 km. From another metre gauge rail head at Kathgodam, there is a all-weather road to Naini Tal from where Ranikhet is connected by another road that crosses the Kosi river near Khairna. From Khairna, all along Kosi there is a motor road via Almora upto and beyond Kausani, the place where the river originates. Almora and Ranikhet are also connected to each other by a good all weather road. The State Transport buses ply on all these roads. Besides, there are inter-connecting semi-metalled fair weather hill roads, numerous mule tracks and footpaths that criss-cross the entire basin area.

Topography and Drainage

The Kosi river originates in the high hills south of Kausani ridge at an altitude of nearly 2480 metres and passes through Someshwar, Hawalbagh, Khairna, Rataura, Seti, Betalghat, Mohan and finally debouches on the alluvial plains near Ramnagar. Upto Someshwar, the river flows through a broad valley and has a wide gently sloping bed. The general flow direction in this part is towards SE with several offests towards east at intervals. From south of Someshwar the channel narrows down, forming terrace deposits (Plates 1 and 2) and upto the confluence of Sual river, the Kosi flows due south in a narrow entrenched gorge. Near Sual river confluence, it takes a westerly bend and then again sharply turns to south near Kakrighat, till it is joined

PLATE 1

View of Kosi valley south of Niral gad, looking upstream.

Shifted meander of Kosi channel (C); formation of flood plain (F) and two terrace levels (T) showing terraced cultivation; the outer bank steep and rocky.

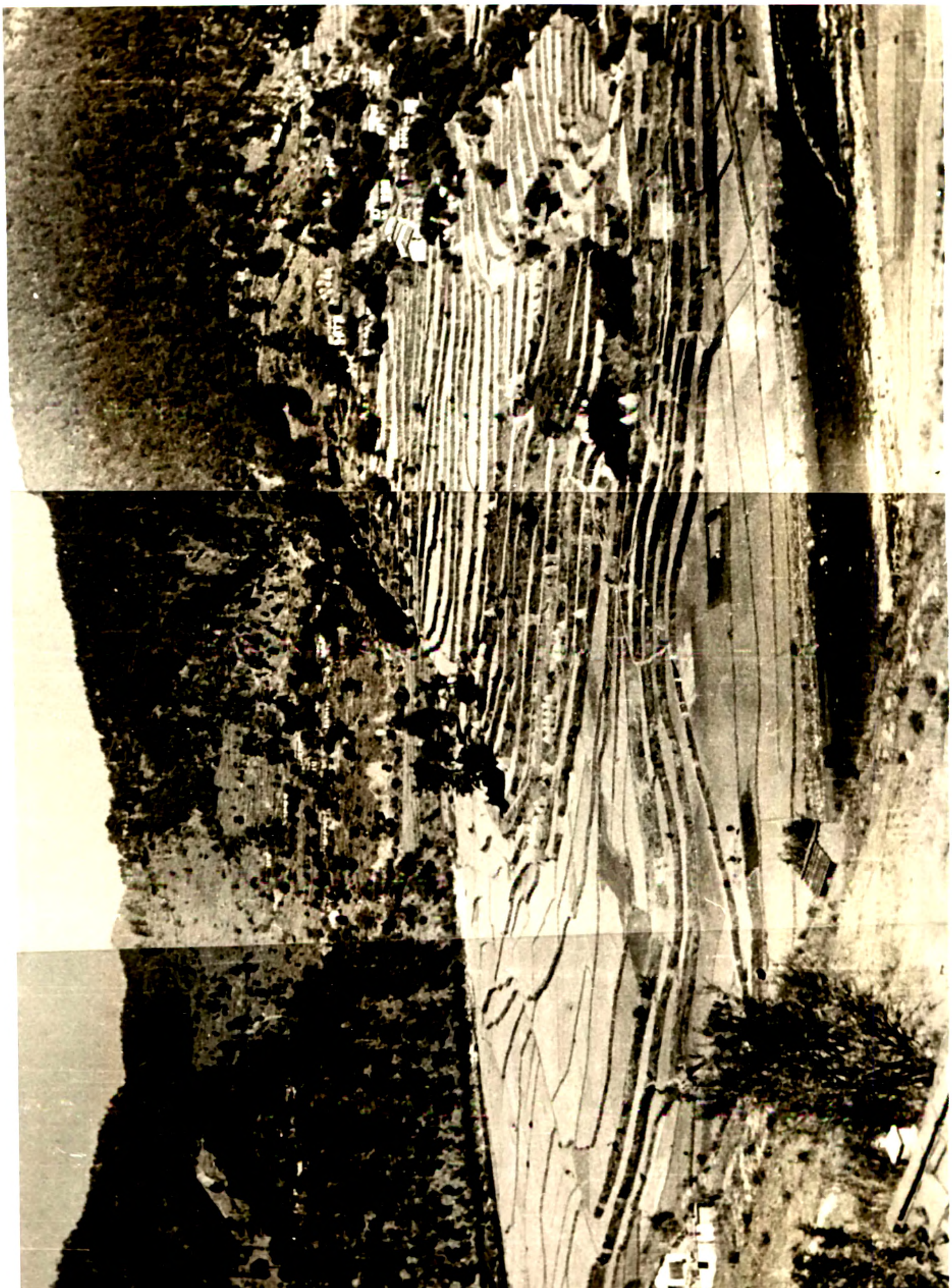


PLATE 2

View of Kosi valley north of Paroliya, looking upstream.

Winding river channel (C) and flood plain (F) forming the valley bottom; the valley sides steep (VS) and forested.

by Khairna nala draining the northern slopes of Naini Tal ridge. At this junction, there is a confluence of Kuch gad which drains the southern slopes of Ranikhet ridge, and the alignment of both Khairna nala and Kuch gad is in a N-S straight line. The Kosi river from this junction flows westwards through wider stretches with alternating short narrow stretches. Near Mohan, the river takes a sharp south-westerly bend, and then flows through a narrow neck north of Garjia before it reaches the 360 metre level near Ramnagar, thus travelling a total length of about 144 km.

From the Kausani ridge the drainage divide bifurcates divergently in the form of a reversed S aligned in EW direction. The two divides come closer, at a distance of about 10.5 km west of Naini Tal. The maximum distance between the two divides is about 36 km between Majkhali and south of Mukteswar. The river discharge (recorded at the only one station - Ramnagar) is maximum between August to October, and averages about 1960 cusecs. The minimum supplies available in Kosi at Ramnagar vary between 115 to 608 cusecs during the months of November to June (Tables 1 and 2, Fig. 3). Thus Kosi is a seasonal river mostly rain fed with a peak flow during August to September and the supplies are moderate unless there is an unusual year of heavy rainfall or cloudburst.

Table 1 : Discharge of Kosi river at Ramnagar
(Monthly average figures in cusecs)

Month	60	61	62	63	64	Average for 5 years
January	372	351	328	402	392	369
February	310	343	314	407	336	342
March	208	299	248	255	289	240
April	209	289	205	225	220	229
May	115	195	168	168	160	161
June	123	209	190	190	134	169
July	240	320	301	368	337	313
August	1471	1797	2808	2844	2063	2196
September	2113	2281	2894	2469	2381	2427
October	1185	1273	1467	1211	1290	1285
November	782	644	608	659	650	668
December	305	450	359	411	306	366

Table 2 : Minimum supplies available in Kosi at Ramnagar during the lean flow period

S.N.	Month	Cusec	Cusec-day
1	November	808	18,240
2	December	305	9,445
3	January	328	10,168
4	February	310	8,680
5	March	209	6,479
6	April	205	6,150
7	May	115	3,565
8	June	123	3,690

Climate

The information on the climatic conditions of the study area is based on the data available from 5 stations i.e. Ranikhet, Almora, Mukteswar, Naini Tal and Ramnagar (Table 3). Of these, Naini Tal is located near a lake on the southern side of Kosi divide and Ramnagar is located at the basin mouth. Thus, these two stations do not really contribute towards the Kosi drainage area, but do indicate the variation of rainfall within the basin.

The rainfall is of monsoon type, the rain-carrying winds shower maximum precipitation along the foot-hill zone, and the rainfall decreases towards the inner areas. High locations like Naini Tal and Ranikhet ridges receive snowfall of short durations in the winter season.

Naini Tal has a maximum annual rainfall of 2670 mm. Next comes Ramnagar with 1637 mm annual average. Towards the inner areas, the rainfall gradually decreases a little, the average rainfalls for Mukteswar, Ranikhet and Almora being 1359, 1293 and 1082 mm respectively. The principal rainfall period is between June to September and more than 70% of the total rain falls during this period (Fig. 3).

The hill stations like Naini Tal, Mukteswar, Almora and Ranikhet, located on the drainage divide experience cold winters and pleasant summers. Naini Tal and Ranikhet have short duration winter snowfalls, whereas in Almora they are occasional. In winter, the morning temperatures are near freezing point for a month or so. The valley portions are warmer having warm summers and pleasant winters. The maximum summer temperatures reach about 25°C in the hilly portions and more than 30°C in the valleys in the months of May-June.

Vegetation

Natural vegetation flourishes in relation to its developmental factors and remains in total balance with it. The factors which determine the variation in these plant communites are altitude, climate (temperature, rainfall), surficial deposits, slopes and slope aspect. Out of these, the factors of altitude and slope aspect are most important.

The Kosi basin shows a great diversity with respect to altitude, climate and surficial deposits, and this diversity is reflected in the distribution of natural vegetation. In altitude, the area ranges from 300 metres near the plains to as much as 2500 metres near its source. The temperature varies considerably from south to north and also from the river valleys to hill summits. Geologically too, the variation is marked from Terai Bhabar alluvium to hill rocks of varying composition in the Lesser Himalaya. There is also a variation in the annual rainfall. All these when combined with slope and slope aspect, have a great effect on vegetation not only in the magnitude and mixture of species but also in the quality and density of the forests. Following broad groups can be distinguished on the aerial photos and in the field:-

a) Sub-montane forests (lower foot-hills - Bhabar and Terai)

(i) Predominantly Sal : Sal on higher ground (Thaplas). The zone continues upto 400 metres altitude.

(ii) Miscellaneous - (a) Hill Kokat, on lower hills, on dry hot slopes and damp nallas (subordinate species like Bakali, Dhauri, Bilwas, Jamun also occur).

(b) Bhabar Kokat occurs at lower levels between Sal forests and is mixed with trees like Semal, Haldu, Sain and Canju.

(c) Riverine trees. Occurrence of Khair (Katha tree) and Sisu (useful furniture tree).

b) Himalayan forests: The Lesser Himalayan zone above the Siwalik foot-hills is the home of conifers (cone bearing trees with needle-like foliage) and evergreen oaks. These occur in following well defined but overlapping zones according to altitude, slope and slope aspect:

(i) Chir pine - It is the lowest and most extensive belt of needle pine. It has invaded Sal zone down to 500 metres in river valleys and is being invaded in its upper limit of 2200metres by oak trees chiefly Banj which spreads down to nallahs.

(ii) Deodar and Kail - Between 1600 to 2700 metres, Deodar and Kail (blue pine) occur in association. These grow in small pockets.

The High Himalayan forest types are not represented in the basin.

Land Use

Except for the reserved forests, rest of the area is under terraced cultivation for crops. All along the basin, the agricultural zones are confined to the lower valley-side slopes, and the total area under cultivation amounts to 50%. Important linear cultivated zones are in the Someswar valley along Kosi River, Deo gad, Sim gad and Lamgara gad and along the terraced slopes all along Kosi, Nana Kosi, Sual River, Kuch gad. The narrow flood plain and the alluvial terrace zone along the Khairna nala are also under cultivation.

PREVIOUS WORK

Comparatively little work has been done in the past on the geomorphology of the study area, and in the course of last 125 years, the various investigators have mostly paid attention to the geological aspects only.

The earlier geological investigation in the Kosi Basin dates as far back as 1851 when Strachey (1851) gave the first geological section across the Kumaon Himalaya. In this section, the lithostratigraphic units recognised were the Recent alluvial plain, Tertiary Siwalik strata, Palaeozoic sediments, metamorphic schists forming an anticline with greenstones in the Naini Tal Almora region. In a later section by Burrard and Hayden (1934) the Siwaliks were classified into the Upper and Lower, while the entire Pre-Siwaliks were put up as Purana group with granitic intrusion in the Almora region.

Heim and Gansser (1939) gave a rather good account of the rocks that lie within the basin, and their's is the first important study. Subsequently, a number of workers, viz,(Pande et al., 1963), Sarkar (1965), Merh and Vashi (1965), Merh (1968), Misra et al. (1973) took up geological studies in the various parts of the study area. The present author too (Chansarkar 1968a, 1968b) has conducted some photogeological investigations. The most recent work on the Himalaya by Gansser (1964) provides an excellent account of the geologic set up of the Kumaon Himalayas. In fact, his study being lucid and convincing, has appropriately provided the regional framework for the present author's morphological study of the Kosi Basin. The author has relied mainly on Gansser's work for geological details. He has however also taken into consideration the work of the students of Merh - (Vashi, 1967; Desai, 1969; Munshi, 1972; Patel, 1972; Shah, 1973; Pal, 1973) who have carried out systematic structural studies in the various parts of the Kumaon Himalaya.

On the geomorphological side, as already stated, previous work is not much. The only geomorphic study of some value is that of Middlemiss (1890) who worked on the physical geology of Garhwal and Kumaon. He has mentioned the terraces in Ramganga river which forms the NW part just outside the Kosi drainage. Except for the cursory references to the terrace formation and other geomorphic features in the work of Heim and Gansser (1939) and Gansser (1964), no systematic morphologic analysis with emphasis on geological control was taken up by any one in the course of last several decades, except that some mention of the Kumaon morphology has been made by Singh (1967); but his remarks are only of a general nature. The present study by the author therefore is in a way a beginning towards systematic morphologic investigations in the high relief Himalayan terrain.

SCOPE AND METHOD OF WORK

The present study pertaining to the drainage and slope analysis of the Kosi river basin, has been carried out with particular reference to the geologic controls. The author himself being basically a geologist, has critically analysed the lithologic and structural influences on the drainage characteristics and slope distribution in the area. In this context, his investigations have a geological bias, and his approach and methods of study have been accordingly chalked out. The author has also taken into account the role of geomorphic processes in shaping the landscape.

The background knowledge of geology of the area, both inferred from the air photos as well as checked in the field, has been utilised to study the geological impact on the distribution of various slope categories, slope aspects and orientation of channel segments. The effects of cymatogeny on the drainage is also studied, vis-a-vis. river entrenchment. Evidences and causes of rejuvenation and generalised study of the different terrace levels has also been carried out.

The work has been conducted mainly on the latest Survey of India maps and aerial photos of 1:70000 and 1:33000 scale. The inference drawn were checked in the field by personal visits. Morphometric and slope analysis was carried out in the laboratory subsequently. As the base maps were quite reliable, no photogrammetric work was found necessary.

The author could divide the entire Kosi basin into 4 zones - each corresponding to a distinct litho-tectonic unit, and also showing typical morphologic characteristics. From these zones, he further selected one sub-basin each, and carried out their morphometric analysis. The investigations were conducted during the year 1972 to 1974, and the work was carried out in the laboratories of the Geology Department, M.S. University of Baroda and of the

Terrain Evaluation Cell, Ministry of Defence. The author visited the field six times, each trip of about 15 days duration. The intervening periods were utilised for photointerpretation and map work. The various steps of the investigation comprised the following:

a) Preliminary Work

Collection of maps and aerial photos of the study area; reference work on different aspects of this study including collection of background information.

b) Map Study

Study of slopes and drainage from 1:50,000 Survey of India (1966 edition) maps; measuring length and gradient of channels; marking different orders of channels; making a slope map using gliding scale for each sub-basin showing slope angle and direction; calculation of relative relief; measurement of areas using wheel planimeter and graphical methods for different order channel basins and slope categories; plotting of detailed longitudinal and cross profiles.

c) Aerial Photointerpretation

Initial scanning of aerial photos and preparing a master tracing for regional geographic details; marking of run numbers and print numbers showing principal points; finding out photo scale by map and photodistance method for each run; making a pre-field map showing broad geology and geomorphic features; selection of areas for field checks. Detailed stereoscopic study of aerial photos before and after every field check; marking additional details, preparing typical stereopairs for illustrations, marking drainage of sub-basins for comparison of various channel orders on map and photo; making a photogeological map for each sub basin; annotation for terrace levels; estimation of slopes using exaggeration factor and slope conversion chart.

d) <u>Field Work</u>

Field work mainly to check and confirm the inferences and observations made after stereoscopic studies of aerial photos primarily aimed at studying the geomorphic processes operating in the area, particularly (1) the effects of river erosion, (2) changes in the entrenchment, (3) width of river bed, (4) generalised channel gradient, (5) generalised slopes in selected areas, (6) different terrace levels, (7) evidences of rejuvenation, (8) periglacial features and (9) changes in surficial deposits.

e) <u>Analytical and Correlation Study</u>

Study of different order channels in each sub-basin with respect to their numbers, average lengths and areas, according to Horton's laws (1945); determination of relief percentage areas and slope category; percentage areas for each sub-basin; study of the geological controls.

f) <u>Conclusions</u>

Arriving at suitable conclusions based on the above studies in respect of the behaviour of drainage and slopes in relation to the (1) geologic set up, (2) structural details and (3) rejuvenation in this polycylic landscape.